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Diamond Lake
Douglas County, Oregon

National Eutrophication Survey, Corvallis, Oreg

Prepared for

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NATIONAL EUTROPHICATION SURVEY

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REPORT
ON
DIAMOND LAKE
DOUGLAS COUNTY
OREGON
EPA REGION X
WORKING PAPER No. 828

WITH THE COOPERATION OF THE
OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY
AND THE
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JANUARY, 1978

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Oregon Department of Environmental Quality for the professional involvement and to the Oregon National Guard for conducting the tributary sampling phase of the the Survey.

William H. Young, Department Director, and Harold L. Sawyer, Administrator, and the staff of the Water Quality Control Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

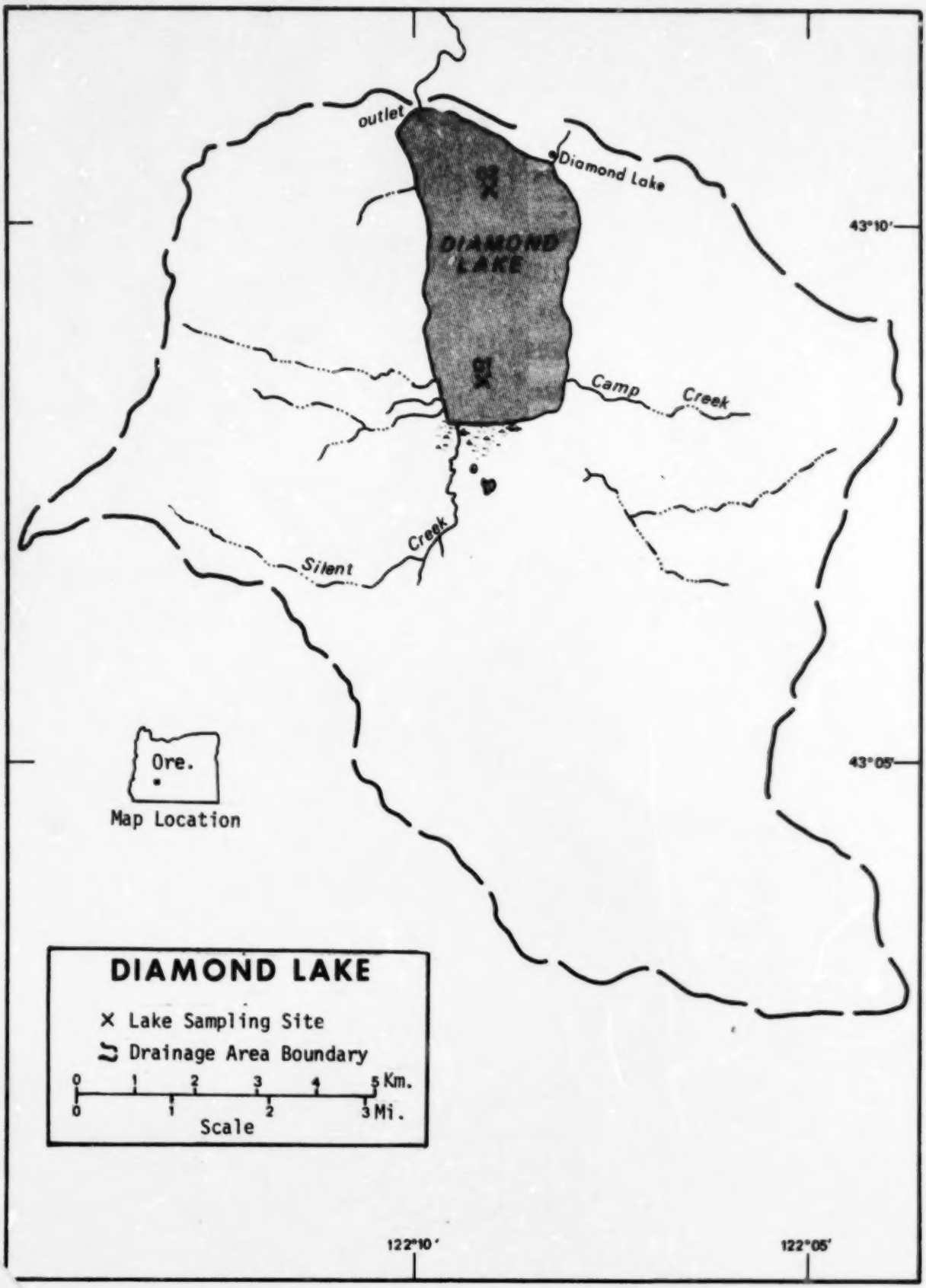
Brigadier General Richard A. Miller, the Adjutant General of Oregon, and Project Officer Lt. Colonel John Mewha, who directed the volunteer efforts of the Oregon National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES and RESERVOIRS

STATE OF OREGON

NAME	COUNTY
Brownlee	Baker, OR; Washington, ID
Diamond	Douglas
Hells Canyon	Baker, Wallowa, OR; Adams, Idaho, ID
Hills Creek	Lane
Owyhee	Malhuer
Oxbow	Baker, OR; Adams, ID
Suttle	Jefferson
Waldo	Lane


outlet
Diamond Lake
DIAMOND LAKE
43°10'
Camp Creek
Silent Creek
Ore.
Map Location
43°05'
DIAMOND LAKE
× Lake Sampling Site
Drainage Area Boundary
0 1 2 3 4 5 Km.
0 1 2 3 Mi.
Scale
122°10'
122°05'

DIAMOND LAKE

STORET NO. 4102

I. INTRODUCTION

Due to inaccessibility, no tributary or outlet samples were collected. Therefore, this report relates only to the lake sampling data.

II. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Diamond Lake is meso-eutrophic. It ranked second in overall trophic quality when the eight Oregon lakes and reservoirs sampled in 1975 were compared using a combination of six lake parameters*. One of the other water bodies had less median total phosphorus and orthophosphorus, none had less and two had the same median inorganic nitrogen, three had less mean chlorophyll a, and one had greater mean Secchi disc transparency. Depression of dissolved oxygen with depth was not detected during Survey sampling, but Sanville and Powers (1971) reported oxygen depletion in September, 1971.

Survey limnologists observed surface concentrations of algae in July and October, and Sanville and Powers (op. cit.) reported late summer blooms of Gloeotrichia sp. and Anabaena sp., as well as large beds of aquatic macrophytes along the lake shore in 1971.

B. Rate-Limiting Nutrient:

Due to changes in the nutrients in the samples during shipment from the field to the laboratory, the algal assay results are

* See Appendix A.

not considered representative of conditions in the lake at the time of sample collection.

The lake data indicate nitrogen limitation in July and October.

C. Nutrient Controllability:

1. Point sources--As far as is known, the only point sources that may be adding nutrients to Diamond Lake are septic tanks serving dwellings along the west shore, but a shoreline survey would have to be done to determine the significance of those sources.

A sewage interceptor system and treatment facility serving the dwellings, campgrounds, and the lodge along the south and east shores of the lake was completed in December, 1975, and eliminated nutrient contributions from those sources (Powers, 1977).

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 13.00 kilometers^2.
2. Mean depth: 6.9 meters.
3. Maximum depth: 15.8 meters.
4. Volume: 90.000 x 10^6 m^3.

B. Precipitation:*

1. Year of sampling: 123.4 centimeters.
2. Mean annual: 117.0 centimeters.

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† Table of metric equivalents--Appendix B.
†† Powers, 1975.
* See Working Paper No. 175.

IV. WATER QUALITY SUMMARY

Diamond Lake was sampled two times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at two stations on the lake (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during both visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths samples were 4.3 meters at station 1 and 9.4 meters at station 2.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR DIAMOND
STORET CODE 4102

PARAMETER	1ST SAMPLING (7/16/75) 2 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (10/31/75) 2 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING 0 SITES RANGE	MEAN	MEDIAN
EMP (C)	10.6 - 17.3	15.9	16.7	7.7 - 8.9	8.5	8.8	******	**********	
ISS OXY (MG/L)	8.2 - 9.2	8.6	8.6	9.8 - 12.0	10.4	10.2	******	**********	
NDCTVY (MCROMO)	21. - 46.	34.	34.	7. - 9.	8.	8.	******	**********	
H (STAND UNITS)	7.2 - 8.4	7.9	7.7	8.6 - 9.0	8.8	8.7	******	**********	
OT ALK (MG/L)	19. - 23.	21.	21.	10. - 25.	17.	21.	******	**********	
OT P (MG/L)	0.011 - 0.045	0.018	0.015	0.027 - 0.060	0.035	0.031	******	**********	
RTHO P (MG/L)	0.009 - 0.033	0.016	0.015	0.004 - 0.011	0.008	0.009	******	**********	
O2+NO3 (MG/L)	0.020 - 0.020	0.020	0.020	0.020 - 0.020	0.020	0.020	******	**********	
MMONIA (MG/L)	0.020 - 0.030	0.021	0.020	0.020 - 0.020	0.020	0.020	******	**********	
JEL N (MG/L)	0.200 - 0.300	0.214	0.200	0.400 - 0.600	0.429	0.400	******	**********	
NORG N (MG/L)	0.040 - 0.050	0.041	0.040	0.040 - 0.040	0.040	0.040	******	**********	
OTAL N (MG/L)	0.220 - 0.320	0.234	0.220	0.420 - 0.620	0.449	0.420	******	**********	
CHLRPYL A (UG/L)	1.9 - 2.2	2.0	2.0	8.1 - 17.0	12.5	12.5	******	**********	
SECCHI (METERS)	4.9 - 5.0	5.0	5.0	5.2 - 5.8	5.5	5.5	******	**********	

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B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
07/16/75	1. Asterionella sp.	2,113
	2. Anabaena sp.	31
	3. Chroomonas (?) sp.	31
	Total	2,175
10/31/75	1. Stephanodiscus sp.	402
	2. Cyclotella sp.	331
	3. Chroomonas (?) sp.	47
	4. Cymbella sp.	24
	5. Epithemia sp.	24
	Other genera	22
	Total	850

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
07/16/75	1	1.9
	2	2.2
10/03/75	1	17.0
	2	8.1

C. Limiting Nutrient Study:

Because of significant nutrient changes in the samples from the time of collection to the beginning of the assays, the results are not considered representative of conditions in the lake at the times the samples were taken.

The lake data indicate nitrogen limitation both sampling times. The mean inorganic nitrogen to orthophosphorus ratios were 3 to 1 in July and 5 to 1 in October, and nitrogen limitation would be expected.

V. LITERATURE REVIEWED

Powers, Charles F., 1975. Personal communication (lake morphometry). EPA, Corvallis, OR.

_____, 1977. Personal communication (status of treatment facilities at Diamond Lake). EPA, Corvallis, OR.

Sanville, William D., and Charles Powers, 1971. Diamond Lake Studies--1971. Prog. Rept. No. 1, Working Paper #8. National Eutrophication Research Program, EPA, Corvallis.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
4101	BROWNLEE RESERVOIR	0.079	0.560	428.133	16.207	14.500	0.043
4102	DIAMOND LAKE	0.028	0.040	294.500	7.300	6.800	0.011
4103	HELLS CANYON RESERVOIR	0.068	0.640	429.111	18.722	12.400	0.045
4104	HILLS CREEK RESERVOIR	0.038	0.060	435.200	2.333	7.400	0.027
4105	OWYHEE	0.095	0.425	480.417	3.350	13.200	0.064
4106	OXBOW RESERVOIR	0.071	0.690	425.555	10.311	12.200	0.040
4107	SUTTLE LAKE	0.031	0.040	95.000	9.167	6.800	0.020
4108	WALDO LAKE	0.005	0.040	-100.000	0.350	6.800	0.006

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
4101	BROWNLEE RESERVOIR	14 (1)	29 (2)	43 (3)	14 (1)	0 (0)	29 (2)	129
4102	DIAMOND LAKE	86 (6)	93 (6)	71 (5)	57 (4)	86 (5)	86 (6)	479
4103	HELLS CANYON RESERVOIR	43 (3)	14 (1)	29 (2)	0 (0)	29 (2)	14 (1)	129
4104	HILLS CREEK RESERVOIR	57 (4)	57 (4)	14 (1)	86 (6)	57 (4)	57 (4)	328
4105	OWYHEE	0 (0)	43 (3)	0 (0)	71 (5)	14 (1)	0 (0)	128
4106	OXBOW RESERVOIR	29 (2)	0 (0)	57 (4)	29 (2)	43 (3)	43 (3)	201
4107	SUTTLE LAKE	71 (5)	71 (5)	86 (6)	43 (3)	86 (5)	71 (5)	428
4108	WALDO LAKE	100 (7)	93 (6)	100 (7)	100 (7)	86 (5)	100 (7)	579

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4108	WALDO LAKE	579
2	4102	DIAMOND LAKE	479
3	4107	SUTTLE LAKE	428
4	4104	HILLS CREEK RESERVOIR	328
5	4106	OXBOW RESERVOIR	201
6	4101	BROWNLEE RESERVOIR	129
7	4103	HELLS CANYON RESERVOIR	129
8	4105	OWYHEE	128

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/12/12

410201
43 08 35.0 122 09 12.0 3
DIAMOND LAKE
41019 OREGON

131092

11EPALES 2111202
0016 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/07/16	11 30	0000	17.3	8.6	192	21	8.40	19	0.030	0.200K	0.020	0.009
	11 30	0005	16.7	8.6		36	8.30	21	0.020	0.200	0.020K	0.016J
	11 30	0010	15.3	8.4		46	8.40	19	0.020K	0.200K	0.020K	0.015J
75/10/31	11 35	0000	8.2	10.2	204	7	8.70	21	0.020K	0.400	0.020K	0.009
	11 35	0005	8.0	10.4		7	8.60	10K	0.020K	0.400	0.020K	0.011
	11 35	0014	7.7	10.2		8	8.60	10K	0.020K	0.400	0.020K	0.011

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/07/16	11 30	0000	0.015	1.9	
	11 30	0005	0.017		
	11 30	0010	0.017		
75/10/31	11 35	0000	0.030	17.0	
	11 35	0005	0.031		
	11 35	0014	0.037		

K= VALUE KNOWN TO BE LESS THAN INDICATED

J= VALUE KNOWN TO BE IN ERROR

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STORET RETRIEVAL DATE 75/08/12

410202
43 10 20.0 122 09 02.0 3
DIAMOND
41019 OREGON

131092

11EPALES 2111202
0034 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/07/16	11 50	0000	17.2	8.2	198	36	7.70	21	0.020	0.200	0.020K	0.012J
	11 50	0005	16.9	9.2		32	7.70	23	0.020	0.200	0.020K	0.011J
	11 50	0015	16.6	8.2		33	7.60	22	0.020	0.200	0.020K	0.015J
	11 50	0030	10.6	9.2		34	7.20	23	0.020	0.300	0.020K	0.033J
75/10/31	11 15	0000	8.9	12.0	228	9	8.70	10K	0.020K	0.400	0.020K	0.004
	11 15	0005	8.8	9.8		8	8.90	23	0.020K	0.400	0.020K	0.005
	11 15	0015	8.8	10.0		8	8.90	25	0.020K	0.400	0.020K	0.005
	11 15	0031	8.8	10.0		8	9.00	22	0.020K	0.600	0.020K	0.009

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/07/16	11 50	0000	0.011	2.2	
	11 50	0005	0.012		
	11 50	0015	0.011		
	11 50	0030	0.045		
75/10/31	11 15	0000	0.027	8.1	
	11 15	0005	0.031		
	11 15	0015	0.031		
	11 15	0031	0.060		

K= VALUE KNOWN TO BE LESS THAN INDICATED

J= VALUE KNOWN TO BE IN ERROR